Nearshore Beach Seining for Juvenile Chinook (*Oncorhynchus tshawytscha*) and other Salmonids in King County Intertidal and Shallow Subtidal Zones

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Abstract

The estuarine environment is an important transition and nursery area for juvenile chinook and other salmonid smolts (Healy 1980a). The limited number of studies to determine distribution and habitat utilization of juvenile salmonids in Puget Sound indicate that juvenile salmon are dependent upon the intertidal and shallow subtidal for feeding, refuge and migration corridors. To enhance our understanding of salmonid distribution and habitat utilization in King County, the Central Puget Sound Forum sponsored a beach seining pilot study that concentrated on sampling logistics, presence/absence of juvenile chinook in the nearshore environment, and development of a nearshore fish catch baseline. Beach seining was conducted weekly at six locations throughout the study area from June 5 to August 16, 2000. Each site was only sampled during daylight hours, but there was temporal and spatial variability due to natural tidal cycles, and sampling times during the study period.

Chinook smolts were the most abundant salmonid encountered. Coho, sockeye, chum, steelhead and cutthroat trout juveniles were found in smaller numbers. Preliminary analyses indicate that tide stage did not seem to affect the total catch of salmonid species. However, additional sampling and a comparative analysis are warranted. Substrate and slope might have an effect on species composition but beach seining is biased towards shallow sloping, sandy substrates. Comparisons with coarser substrates cannot be inferred. Other common fish species encountered included staghorn sculpins, shiner surfperch, sand lance, smelt, flatfish and gunnels.

Introduction

Historical data on salmonid distribution, abundance, and habitat utilization in King County nearshore waters are extremely limited. However, studies of salmonids in Puget Sound nearshore waters indicate that juvenile salmon are highly dependent upon the intertidal and shallow subtidal for feeding, refuge and migration corridors (Beamish and others 1998; Healy 1980a). This estuarine environment is also an important physiological transition area and nursery for juvenile chinook (*Oncorhynchus tshawytscha*) and other salmonid smolts (Healy 1980a). The recent listings of chinook salmon and bull trout under the Endangered Species Act (ESA) have increased our need to for an improved understanding of salmonid distribution and habitat utilization, and the impacts that result from habitat alteration. To fill the gaps in our understanding of salmonid timing, distribution, abundance, and habitat utilization we determined that a strategic sampling program of King County marine nearshore waters was critical to our habitat assessment and salmon recovery efforts. This knowledge is needed to enable more effective biological evaluations and assessments under Section 7 and Section 10 of the Endangered Species Act, and to aid planners and land use decision-makers.

The year 2000 beach seining effort was designed as a pilot study to work out sampling logistics, determine presence/absence of juvenile chinook and other salmonids in the nearshore environment, and to develop a baseline of nearshore fish species composition. Sampling was originally designed to utilize low tide periods because most juvenile salmonids collected in previous studies were captured during low tide when the seine was set furthest from the shore (Norman 1998). Due to logistical problems with trying to sample just at low tide, we decided that sampling would occur at various tidal elevations to get a better understanding of juvenile salmonid distribution and habitat utilization.

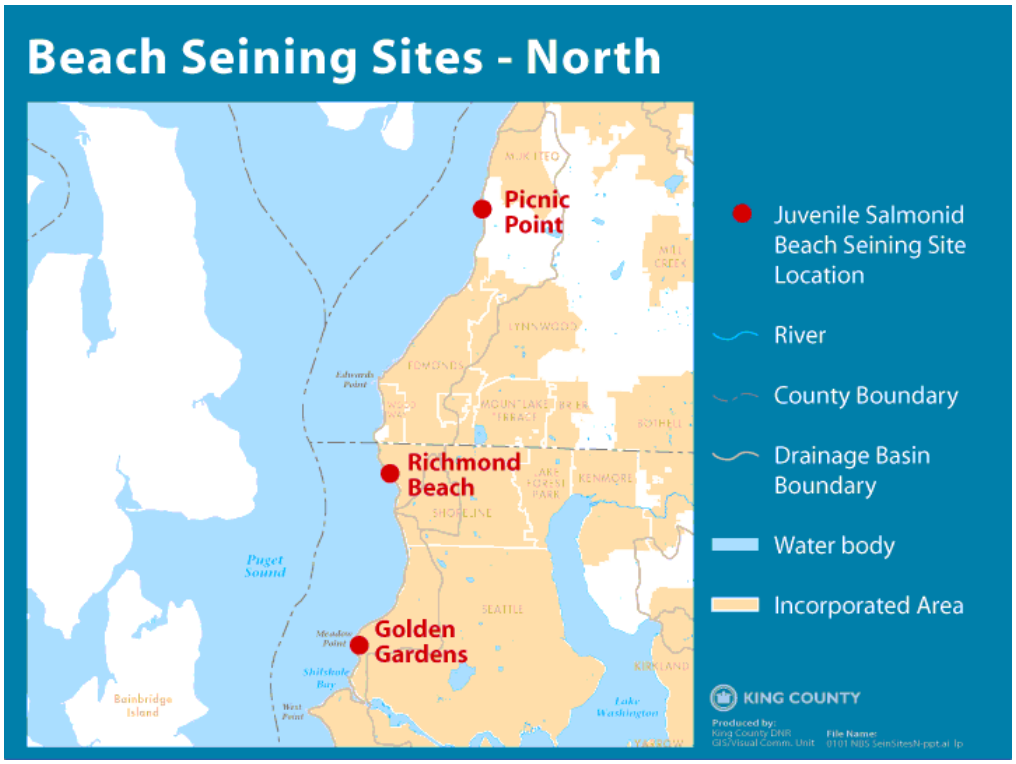

Figure 1 North King County juvenile salmonid beach seining site locations

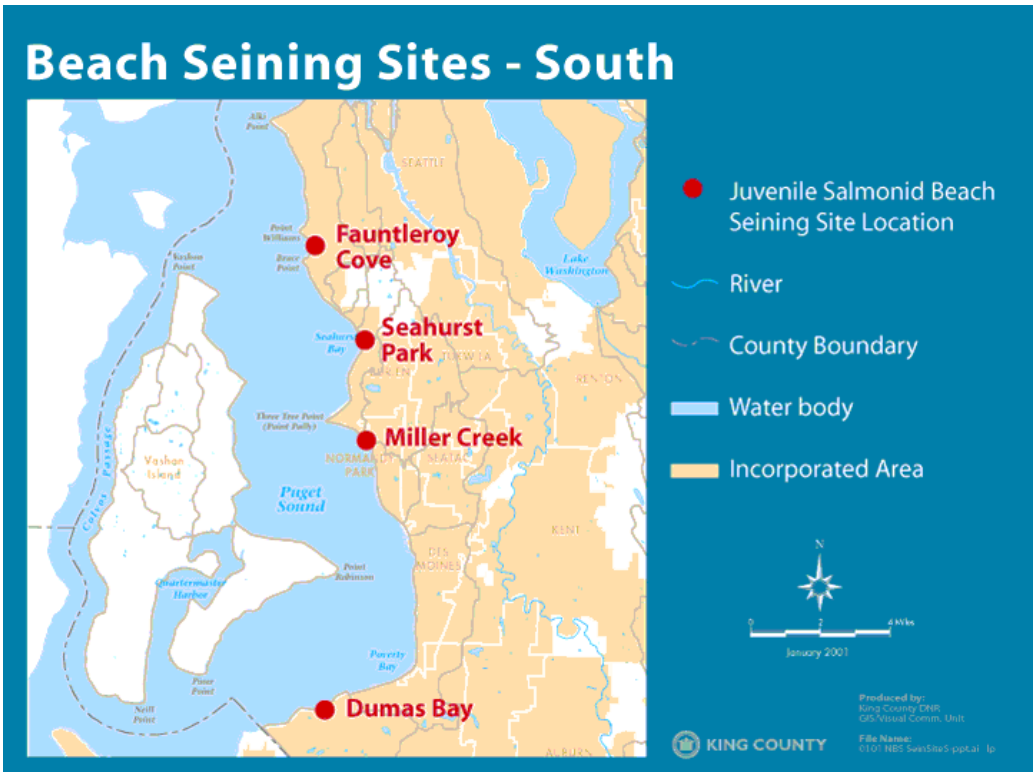

Figure 2 South King County juvenile salmonid beach seining site locations

Beach Seining Methods

Beach seining was conducted between June 5 and August 16, 2000 at seven locations throughout the study area, including: Picnic Point, Richmond Beach, Golden Gardens, Fauntleroy Cove, Seahurst Park, Miller Creek, and Dumas Bay. Sites were selected for ease of upland access and their distribution throughout the study area. Each site was only sampled during daylight hours, at various tidal elevations due to natural tidal cycles.

A 30m x 1m beach seine was set by hand from a fixed point at the waterline, perpendicular to shore until the net was fully deployed. After the net was completely deployed, it was pulled in a sweeping arc towards shore while the onshore person remained stationary. Once both ends of the net were on the beach, both wings were pulled ashore simultaneously, while keeping the leadline on the bottom, until the cod end was almost to the beach.

A second deployment method was also used. In this method, the net was set parallel to shore at a depth of approximately 1.5 meters, and each end of the net were pulled ashore simultaneously (Simenstad 1991). This is the method that is typically used in deploying a 37m beach seine and was used to test the efficiency of both seine methods on beaches of varying slopes. Once the net was brought to shallow water, all fish were enumerated and identified to species. Some of these counts for species such as shiner perch, staghorn sculpins and other species caught in large numbers were “estimated” due to the need to process the catch quickly in order to avoid mortality. Salmonids were measured to Fork Length (FL) and released unharmed. Chinook smolts received preferential treatment since this was the target species of concern. In order to compare juvenile chinook catches from each site, an estimate of the average catch of chinook per haul was used, regardless of how long it took to deploy an individual haul. Salmonids that had adipose fin clips were considered "hatchery" fish and the non-clipped salmonids were considered “wild” fish.

Beach seining was conducted two days per week (Tuesday and Wednesday), with three sets per day at each site from June 5 to August 9, 2000. Each haul was marked with a GPS receiver (Fig. 3) and replicate hauls were not performed at the same position (i.e., non-overlapping sets). If vegetation clogged the nets or if debris and or large rocks interfered significantly with the set, the haul was abandoned and the fish were released unharmed.

Figure 3 Beach seining sites on Richmond Beach as indicated by GPS.

Results

Chinook (*O. tshawytscha*) and coho (*O. kisutch*) smolts were the most common salmonid species encountered. Sockeye (*O. nerka*), chum (*O. keta*), steelhead (*O. mykiss*) and cutthroat (*O. clarki*) trout juveniles were found in smaller numbers and were encountered early in the season. Chinook smolts were the most abundant salmonid and were captured in densities of up to 24 smolts per haul, but most hauls averaged 2-4 smolts (avg catch/haul = 1.9 for juvenile chinook). The size of chinook smolts captured in late June averaged 85mm, 100mm in July and 130mm in August (Fig. 4). Chinook smolt size varied among these means and there was no noticeable size differentiation between wild and hatchery smolts.

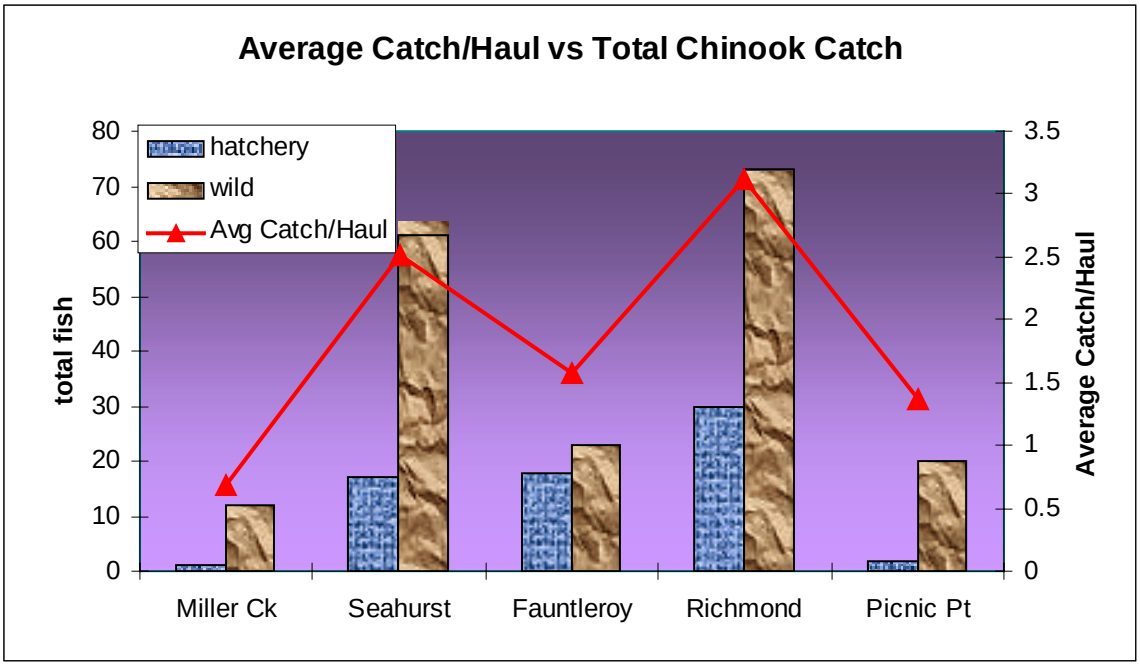

Figure 4 Average Catch Per Haul and total juvenile chinook catch at nearshore sampling sites.

Coho were encountered until mid-August, but in numbers far less that chinook. An average of one to four fish per haul was exceptional for coho. A few large (~200-300 mm) cutthroat trout were captured at the Miller Creek, Seahurst Park and Richmond beach sites in early June, but large cutthrout trout were absent from any subsequent catches. A few large steelhead smolts (~150 mm) were also captured in early June at the Seahurst and Fauntleroy and Richmond Beach sites. Numbers of juvenile salmonids captured varied and were not consistent throughout the sampling period (Fig. 5). There was a general trend of decreasing catch toward the end of the summer for chinook, except for Seahurst Park which had consistent numbers throughout the summer.

Catches of wild chinook were higher than hatchery chinook. Numbers of hatchery fish peaked in mid-June and decreased after this time period. Low numbers of both groups were captured in late June with wild fish increasing in our samples during late July (Fig. 6).

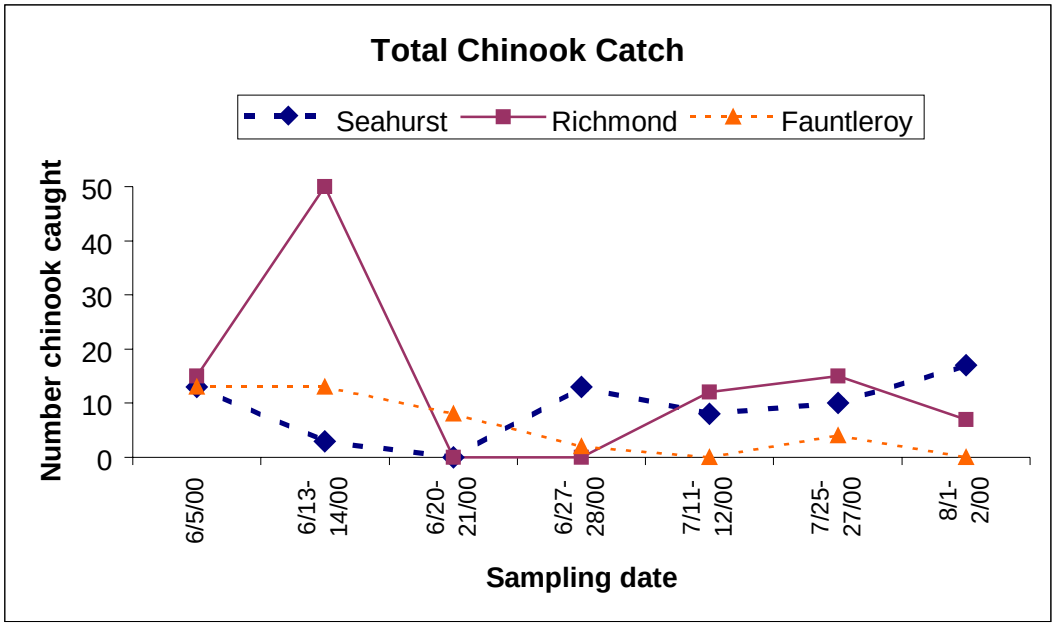

Figure 5 Temporal representation of total chinook catch at the three major sampling sites.

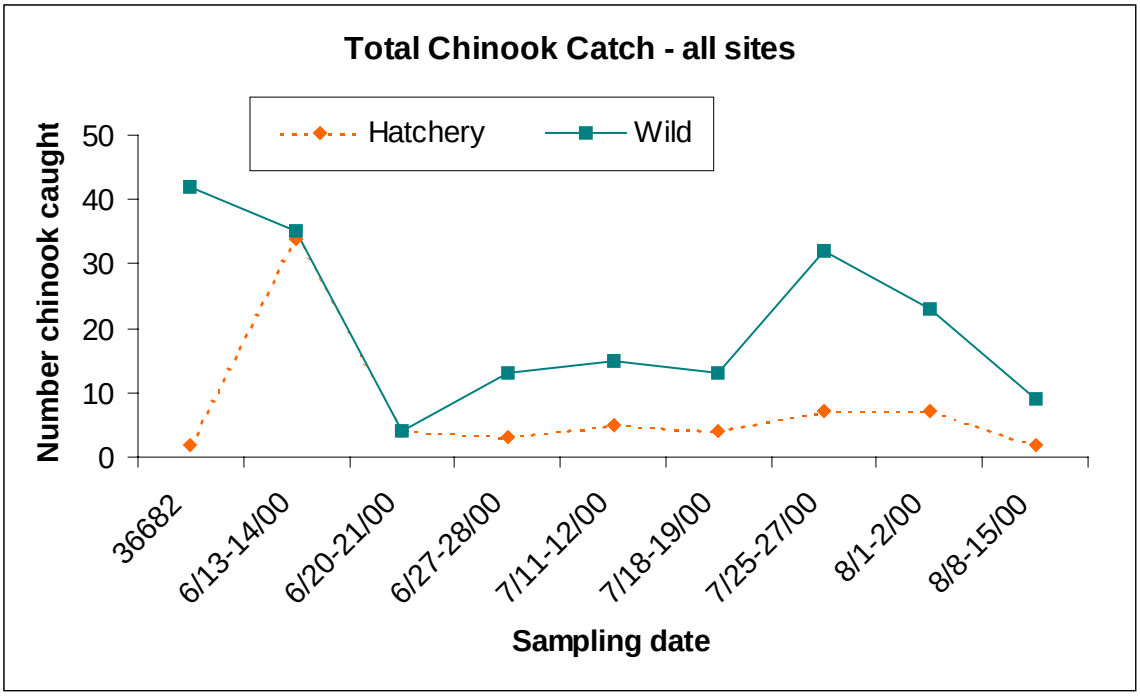

Figure 6 Temporal representation of wild and hatchery chinook catch over all sites. (Note: fish that had adipose fin clips were considered "hatchery" fish.)

Dumas Bay and Miller Creek contained large quantities of *Ulva spp.*, which fouled the nets and probably reduced catch efficiency. Other sites contained less drift algae, which may have contributed to increased numbers of smolts caught. There appeared to be no correlation between tide stage and total catch of salmonid species (Fig. 7). It was interesting to note that the high catches of chinook seemed to cycle between low and high tides (Fig. 7).

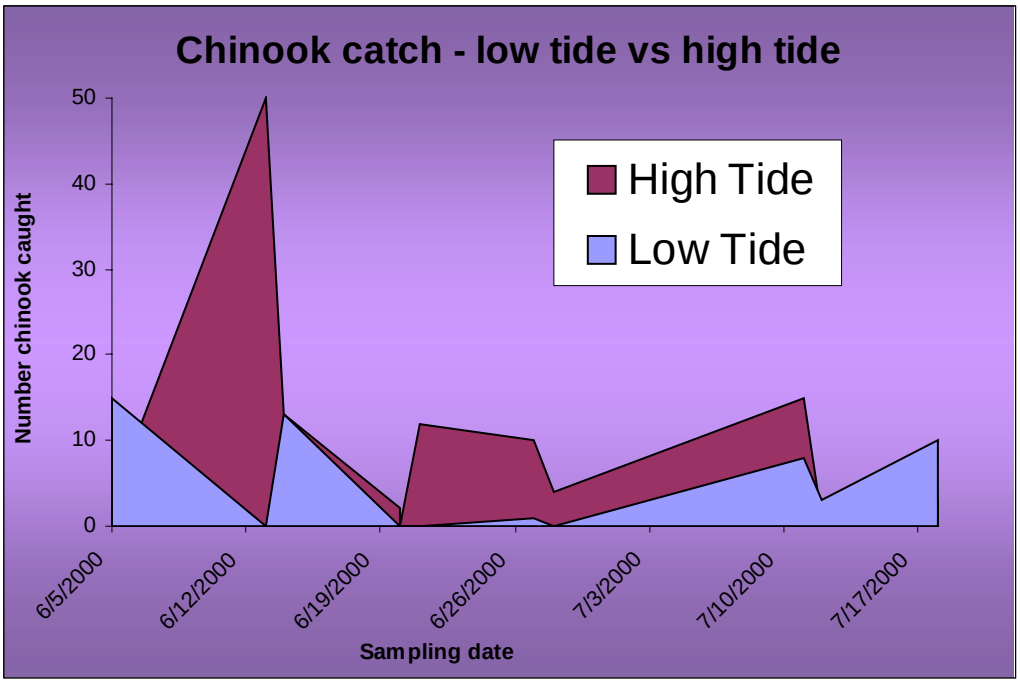

Figure 7 Total juvenile chinook catch versus tidal elevation (Note: low tide was <5 ft., and high tide was > 5 ft.).

In addition to juvenile salmonids, the most common fishes encountered were staghorn sculpins, shiner perch, striped perch, sand lance, smelt, flatfish spp., bay pipefish and gunnel spp.. (Fig. 8).

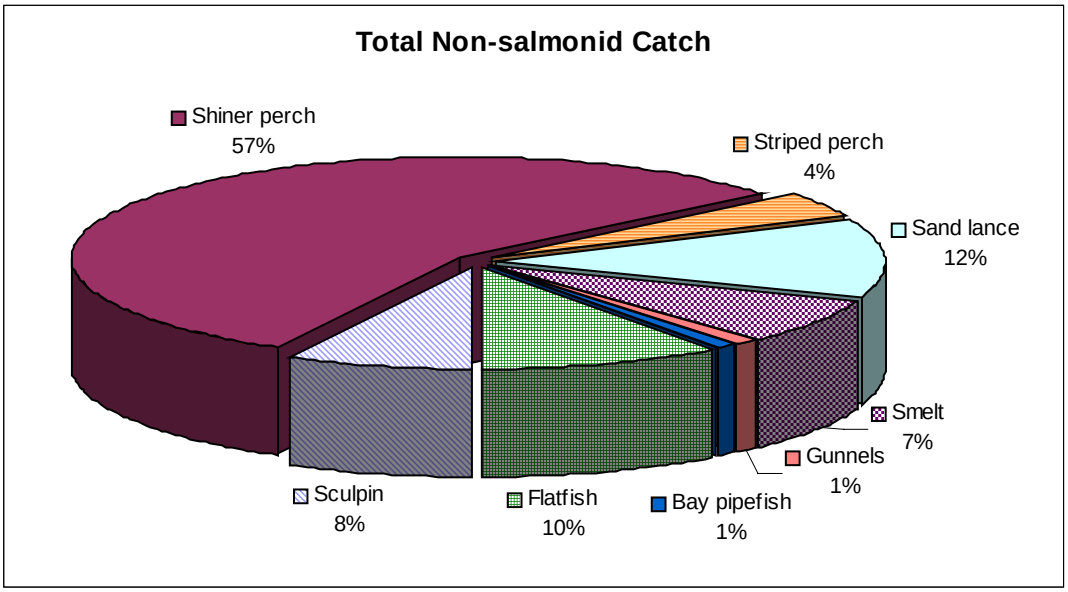

Figure 8 Total catch of eight most common non-salmonid fish in nearshore beach seine haus.

Shiner perch and staghorn sculpins were abundant in the shallow southern beaches that contained nearshore eelgrass beds. Shiner perch numbers and size dwindled toward the end of July when only juvenile shiner perch were caught. Various flatfish species were abundant over sandy reaches, while gunnels, greenling, and bay pipefish were most common near kelp beds.

Conclusions

Juvenile chinook were found at all sites and throughout the sampling period. These findings are similar to those of Healy (1980b), Fresh and others (1981), and Beamish and others (1998), who captured chinook smolts in water depths of a few centimeters to a meter or more deep over gravel, sand, and mud substrates, with and without eelgrass. Beamish and others (1998), found that large numbers of juvenile chinookremain in the Puget Sound at least into the fall of their first year in the marine environment. Although we only sampled until mid-August, chinook smolts were still being captured in our beach seines. Recent data indicate that juvenile chinook are in the nearshore from late January/early February through September, and it is possible that they may be found in the nearshore year-round (Williams and others 2001). There was an increase in wild chinook catch in late July, which may be indicative of late summer outmigration of naturally produced chinook.

Levings and others (1986) found that hatchery fry resided in the Campbell River estuary about half as long as wild fish. Catches of wild chinook were higher than hatchery chinook in our study, but this could be an artifact that not all hatchery fish were clipped. It could indicate that wild smolts might be using the shallow nearshore environment more than hatchery smolts.

Tide stage did not seem to affect salmonid catch. Ledgerwood and others (1991) observed chinook smolt movement to be independent of tidal cycle in the Columbia River estuary, and catches of subyearling chinook to be most effective from sunrise to early afternoon in nearshore waters. One important finding of Ledgerwood and others (1990) was the decreased migration of chinook smolts during hours of darkness. This study was not designed to test diurnal behavior, but is warranted for future studies.

We could not detect any difference in efficiency between the two different seine haul deployment methodologies because there was too much intra-method variability among hauls. Another possible reason that no differences were detectable is that both techniques only sampled water up to 1.5 meters deep and if we were to increase efficiency, we would have to increase our depth and area of beach sampled. Weitkamp and others (1981) indicated that chinook juveniles remain close to the shoreline, within 2-20 ft along steep riprap shorelines but farther from the water line over gradually sloping shores in Shilshole Bay. If we are to sample along steeper slopes and farther out from shore, we must use a larger and deeper seine that is deployed from a boat in order to gain a better representative sample of juvenile chinook in the nearshore.

A baseline of non-salmonid fish was collected in this study. A dietary foodweb analysis and studies of predator-prey interactions are warranted for an improved understanding of competition or if food resources and interspecific interactions are limiting in the nearshore when these species occur sympatrically.

Future Studies

It is anticipated that future 2001 beach seining efforts will include an expanded geographic area with an increased number of sites and sets per site. A paired analysis of disturbed vs. natural sites is also being contemplated to determine if there is preference for relatively natural, undisturbed site selection among juvenile salmonids. Emphasis will also be placed on standardizing sampling logistics, quantifying a standard seine C.P.U.E. (catch per unit effort) using a larger boat deployed seine, and the development of a nearshore fish catch baseline with cooperation between multi-jurisdictional agencies in King County.

Acknowledgements

King County Conservation District funding, Cascadia Quest work crew, CORE Kids, King County Conservation Crew, and many other volunteers from King County DNR who wanted to spend a day at the beach

References

Beamish, R.J., M. Folkes, R. Sweeting, and C. Manken. 1998. Intra-annual changes in the of coho, chinook, and chum in Puget Sound in 1997. Pages 531-541 in Puget Sound Water Quality Action Team, Puget Sound Research '98, Olympia, Washington.

Fresh, K.L., R.D. Cardwell, and R. P. Koons. 1981. Food habits of Pacific salmon, baitfish, and their potential competitors and predators in the marine waters of Washington, August 1978 to September 1979. Progress Report No. 145, Washington Department of Fisheries, Olympia, Washington.

Healy, M.C. 1980a. Juvenile Pacific salmon in estuaries: the life support system. *In* V.S. Kennedy *Ed*. Estuarine Comparisons. Academic Press, New York, NY. pp.315- 341.

Healey, M.C. 1980b. Utilization of the Nanaimo River estuary by juvenile , *Oncorhynchus tshawytscha*. Fishery Bulletin **77:** 653-668.

Ledgerwood, R.D., F.P. Thrower, and E.M. Dawley. 1991. Diel sampling of migratory juvenile salmonids in the Columbia River estuary. Fishery Bulletin **89:** 69-78.

Levings, C.D., C.D. McAllister, and B.D. Chang. 1986. Differential use of the Campbell River estuary, British Columbia, by wild and hatchery-reared juvenile chinook salmon (*Oncorhynchus tshawytscha*). Canadian Journal of Fisheries and Aquatic Sciences **43:** 1386-1397.

Norman, D. 1998. 1997 Dumas Bay Centre Monitoring and Final Recommendations. Report to City of Federal Way, Department of Community Development. 56pp.

Simenstad, C.A. 1991. Estuarine Habitat Assessment Protocol. US Environmental Protection Agency, Region 10. Seattle, WA. 201pp.

Weitkamp, D.E., E. Gullekson, and T.H. Schadt. 1981. Shilshole Bay fisheries resources, spring 1981. Report by Parametrix, Inc. to Port of Seattle, Seattle, Washington. 15p.

Williams, G.D., R.M. Thom, J.E. Starkes, J.S. Brennan, J.P. Houghton, D. Woodruff, P.L. Striplin, M. Miller, M. Pedersen, A. Skillman, R. Kropp, A. Borde, C. Freeland, K. McArthur, V. Fagerness, S. Blanton, and L. Blackmore. 2001. Reconnaissance Assessment of the State of the Nearshore Ecosystem: Eastern Shore of Central Puget Sound, Including Vashon and Maury Islands (WRIAs 8 and 9). J.S. Brennan, Editor. Report prepared for King County Department of Natural Resources, Seattle, WA.